Biodiversity Survey of the Cape (BioSCape)

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NASA

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NRF National Research Foundation | SAEON South African Environmental Observation Network

NASA Field Campaigns

1989-1991	**OTTER** first campaign to use the AVIRIS hyperspectral sensor to study the ecology of western coniferous forests
1999-2001	**SAFARI** (Southern African Regional Science Initiative) biogenic, pyrogenic, and anthropogenic emissions
2011-2016	**HyspIRI** preparatory airborne campaigns to support several terrestrial and marine ecological studies
2015-2025	**ABOVE** (Arctic-Boreal Vulnerability Experiment) 10-year field campaign to understand the socio-ecological implications of environmental change in Alaska and Northwestern Canada
2016	**CORAL** (Coral Reef Airborne Laboratory) globally-extensive airborne imaging spectroscopy survey of coral reefs around the world.
2021-2024	BioSCape (Biodiversity Survey of the Cape)

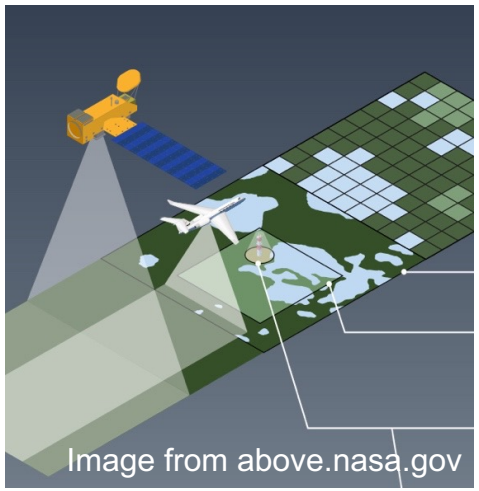
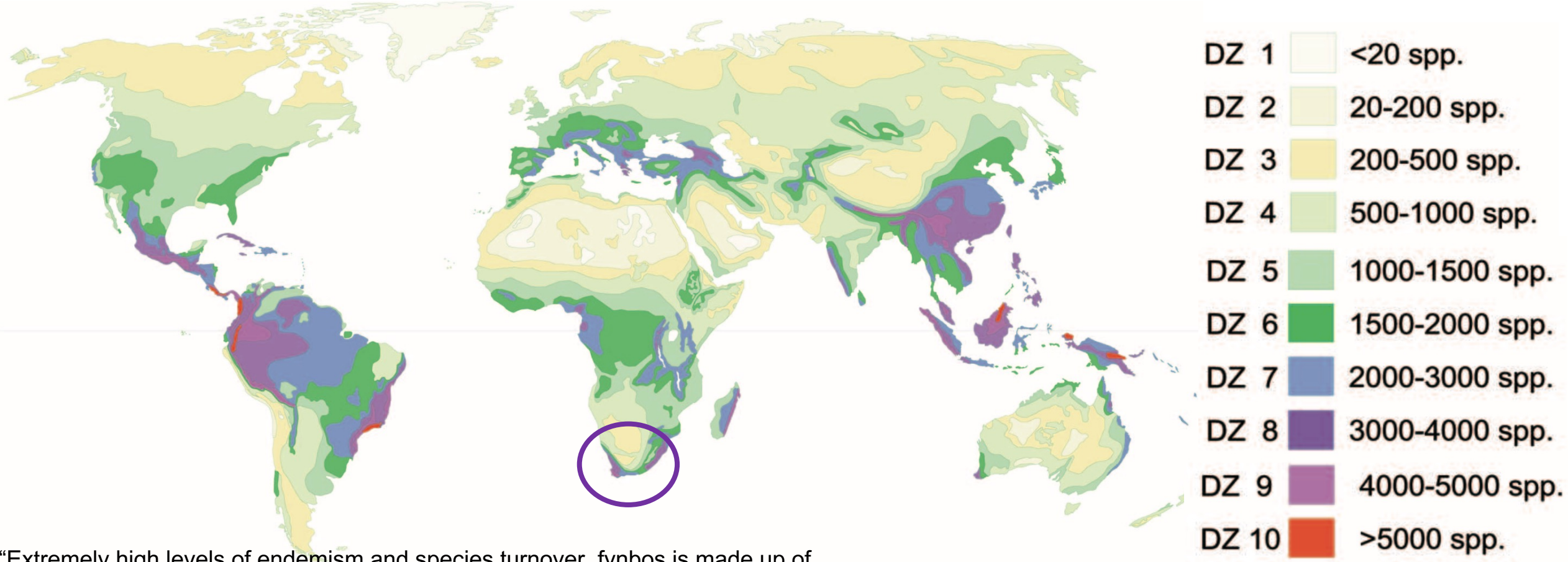


Image from above.nasa.gov

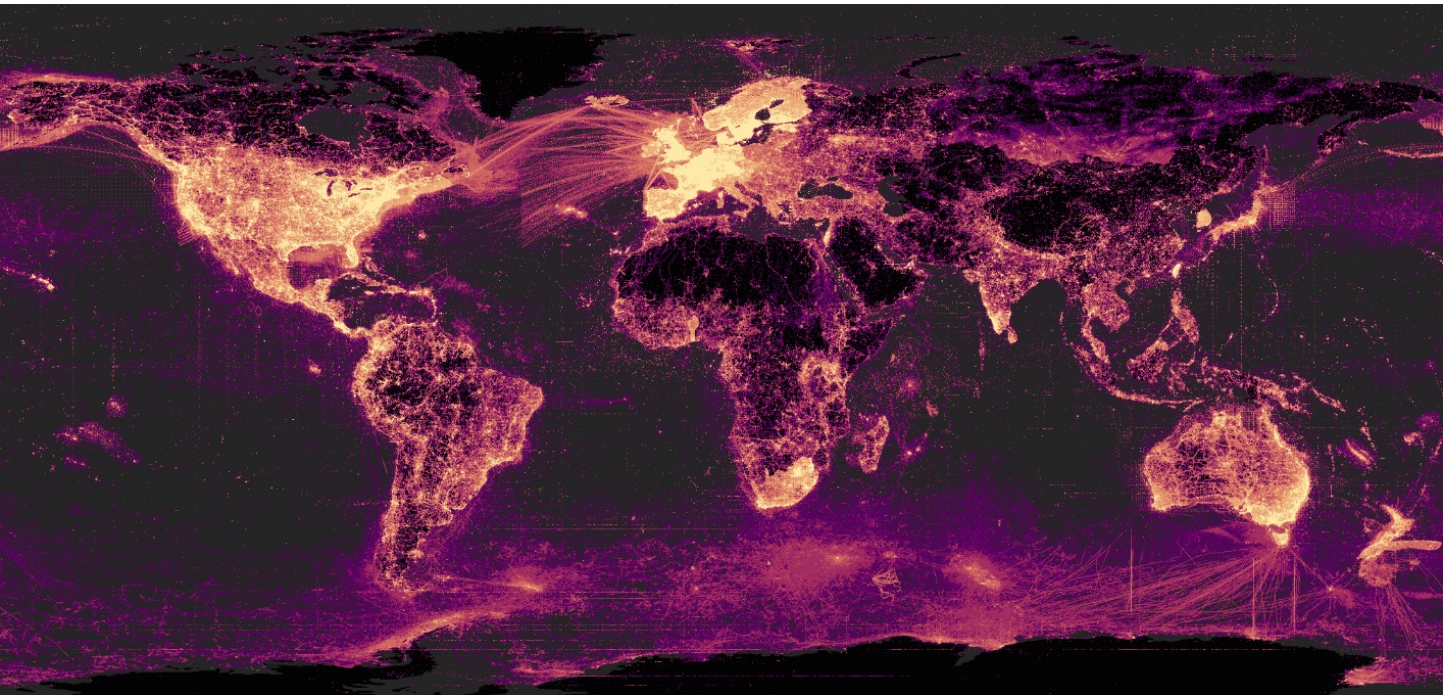
Vascular Plant Diversity: # Species per 10,000km^2



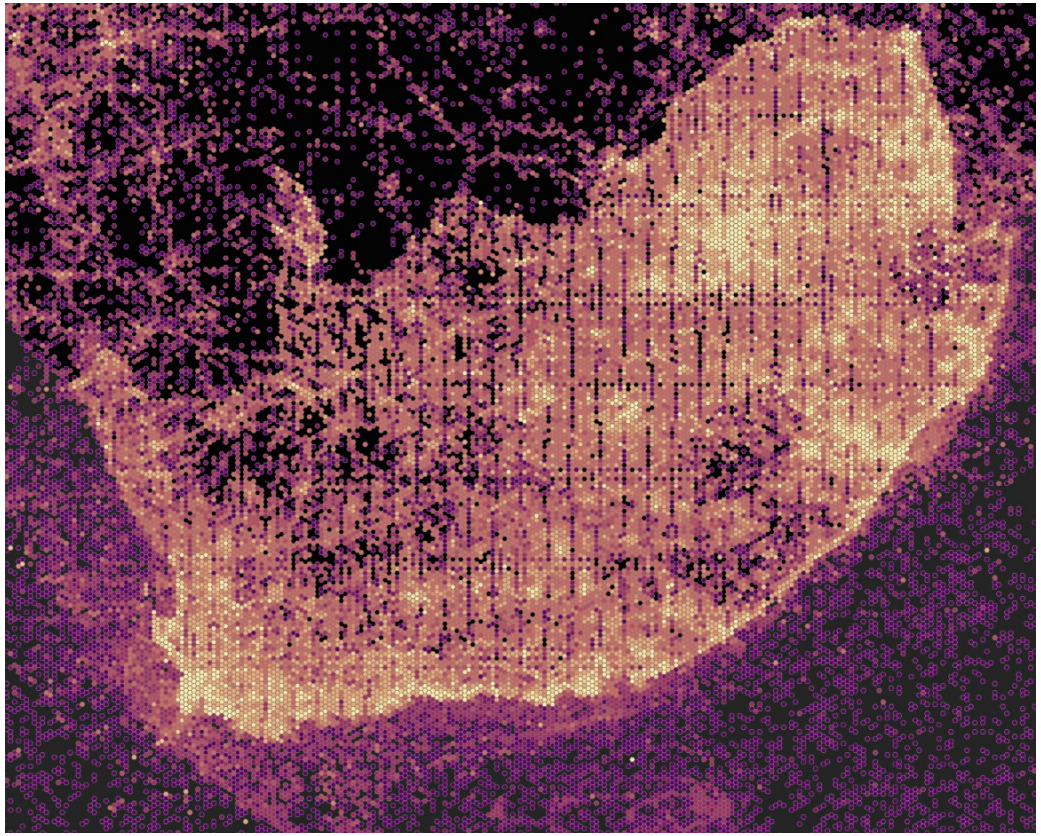
"Extremely high levels of endemism and species turnover, fynbos is made up of dissimilar local communities that are species-rich but relatively poor in rare species."
Latimer (2005) 10.1126/science.1115576

Barthlott, et al., *Nova Acta Leopoldina* , 2005

Digitally accessible biodiversity data density

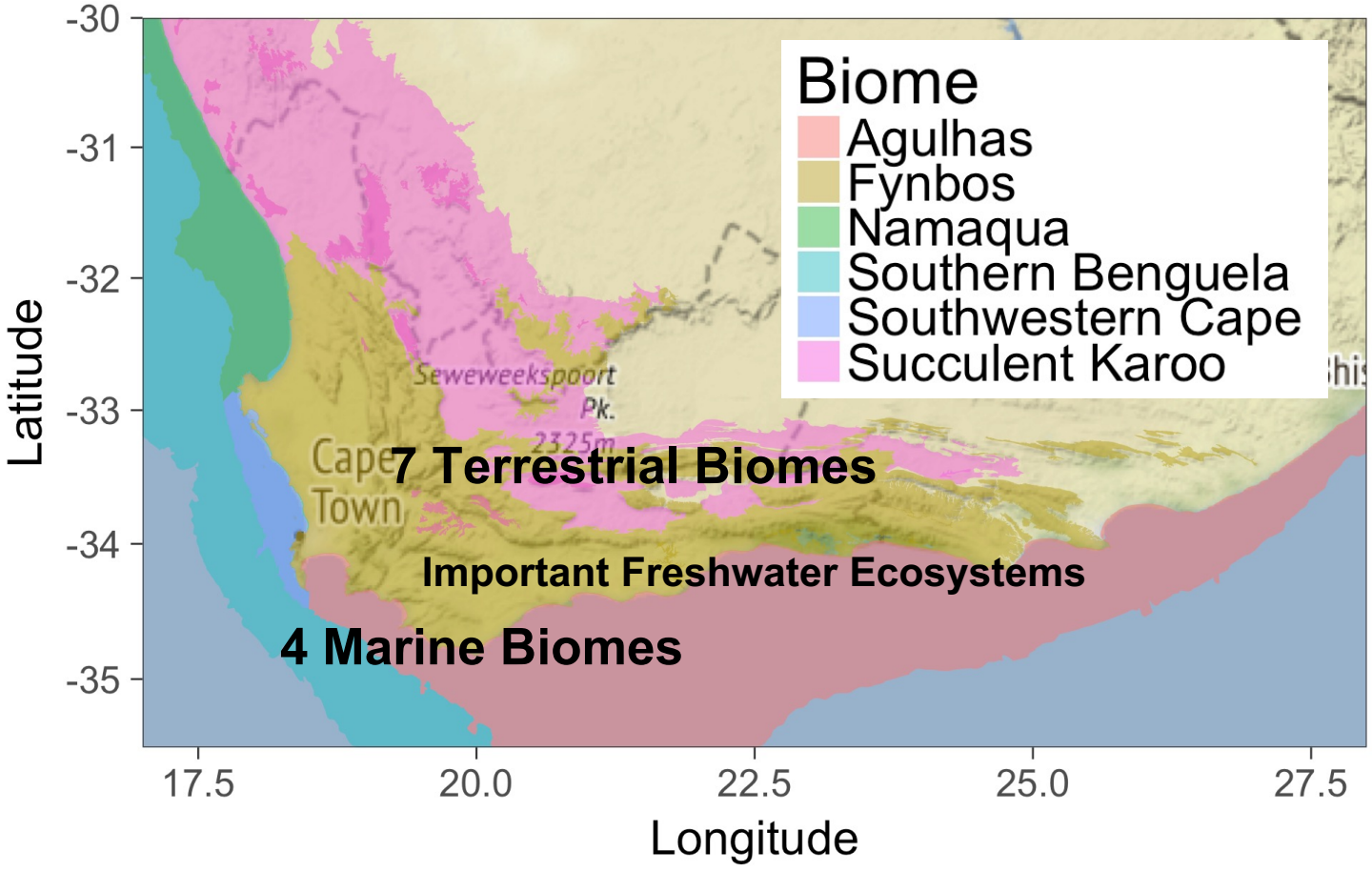


Occurrence Record Counts (2021)



GBIF.org

Greater Cape Floristic Region (GCFR) of South Africa



≈90,000km^2

Outstanding Biodiversity

- ~1% Africa's area
- ≈9,000 vascular plants
  - ~20% Africa's Plants
- 65% endemic
  - ~2.5% world's plants endemic

Socio-ecological complexity

- Climate Change
- Urban Migration

BioSCape Timeline

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- *Proposals in Review*
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- NSF projects?

2023

- **Field Campaign**

2024+

- Analysis and Publication

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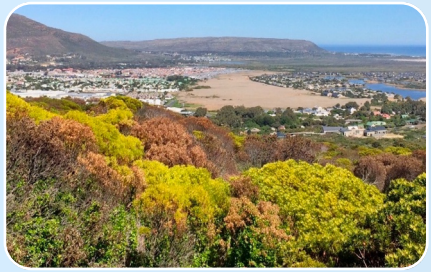
BioSCape Science Themes

Distribution and abundance of biodiversity

- Direct Observation of Indicator Species
- Inferred distributions through RS-informed distribution modeling
- Taxonomic Diversity / Functional Diversity

Role of biodiversity in ecosystem functions

- Biodiversity & ecosystem resilience.
- Relationships between biodiversity and the nitrogen, hydrologic, & carbon-cycles



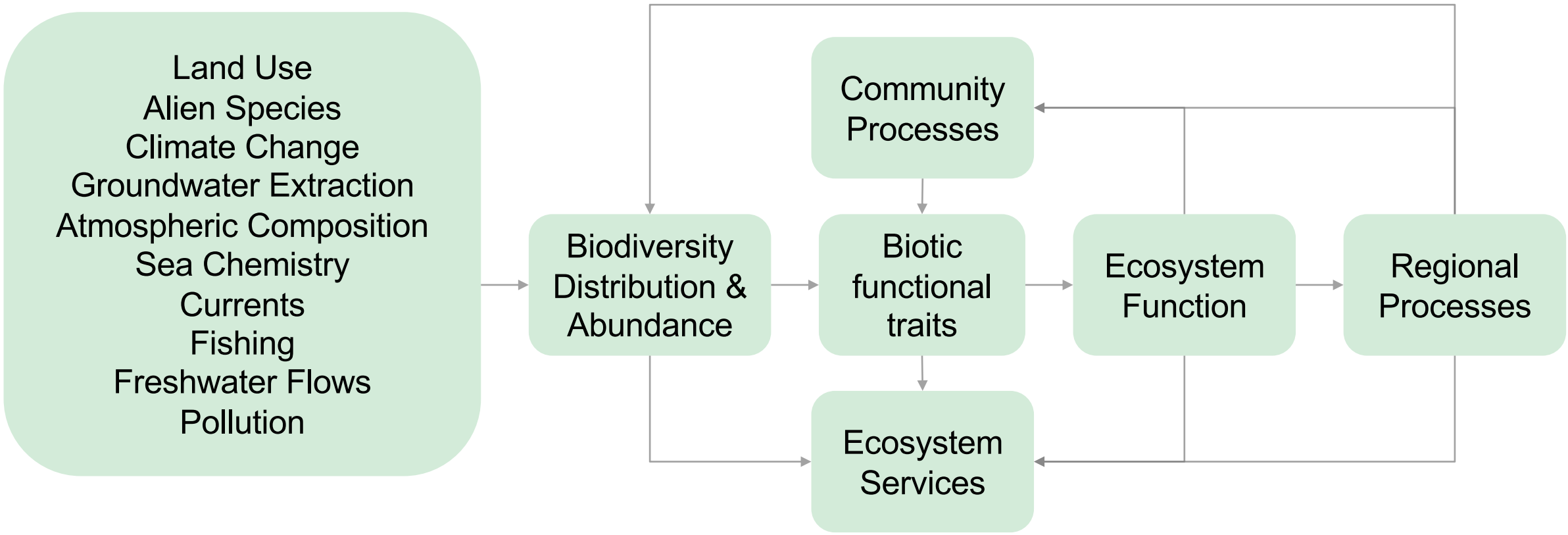
Feedbacks between global change, biodiversity change, & ecosystem services

- Hydrologic variability and biodiversity and ecosystem function
- Feedbacks climate & wildfire

Terrestrial, Freshwater, & Marine

Global and Regional Relevance

Socio-ecological Processes

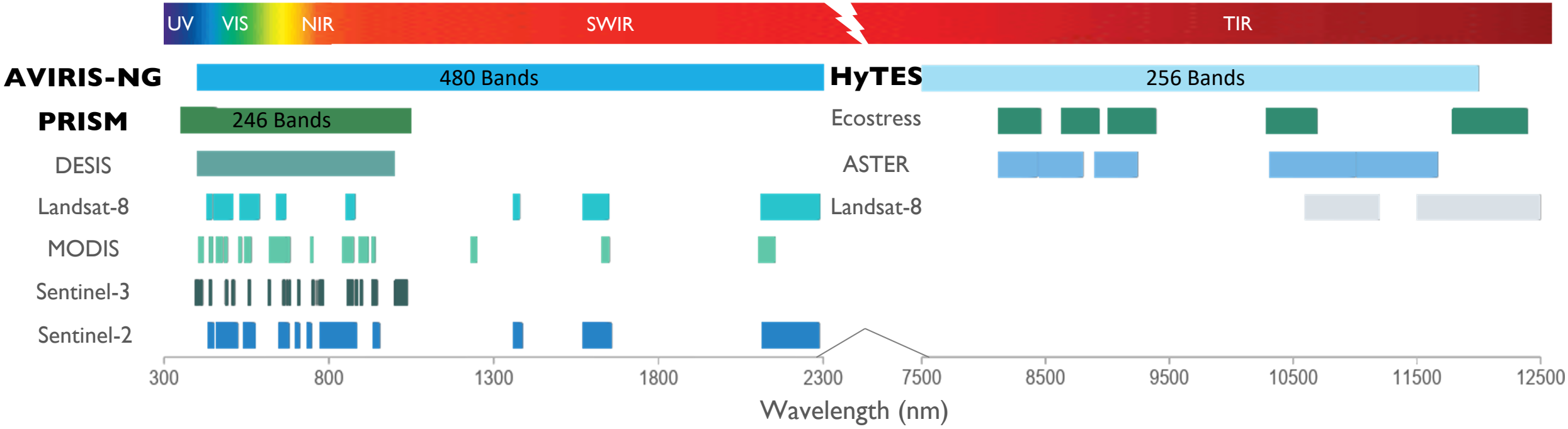


adapted from Slingsby, et. al. (2014)

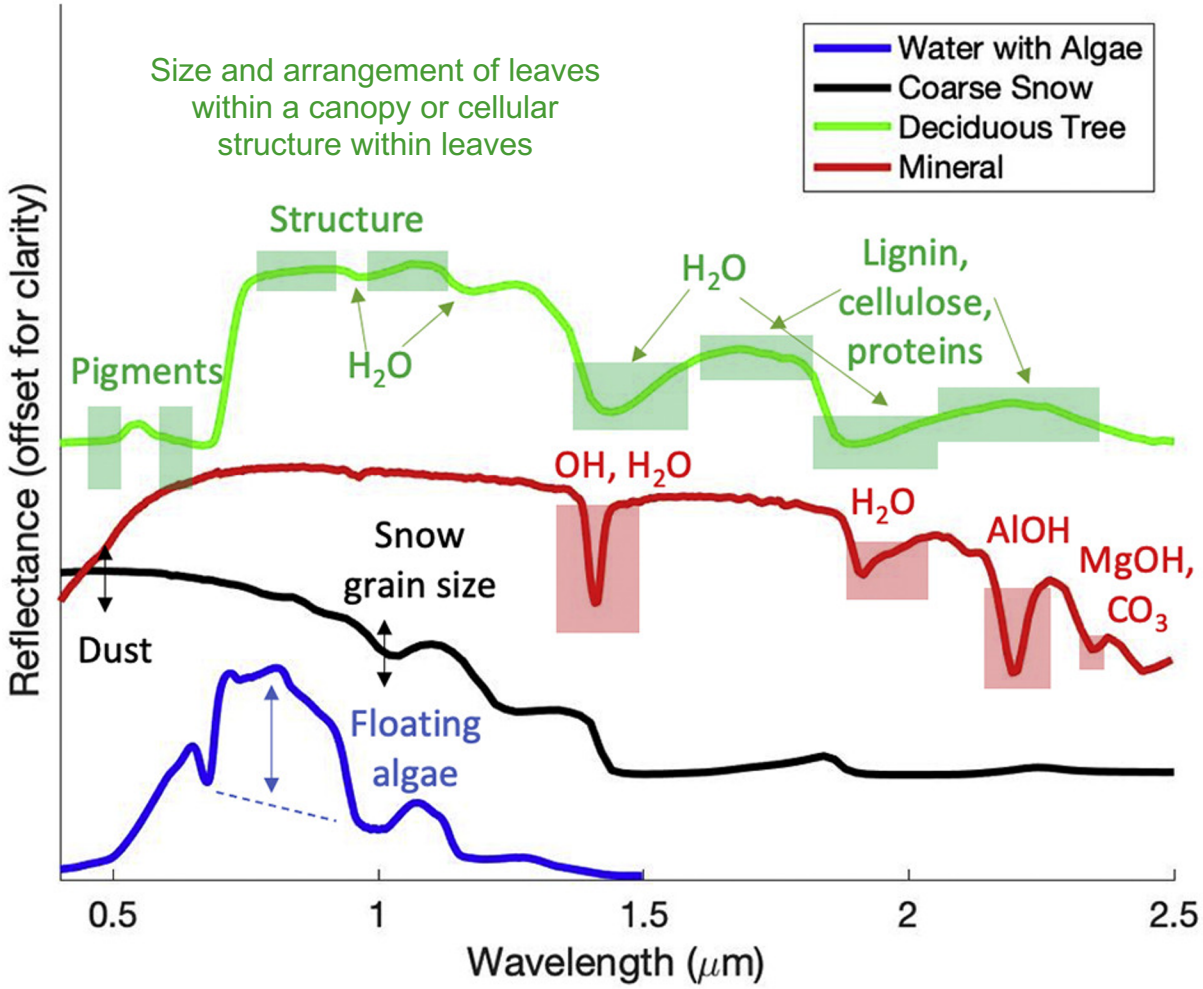
Platform & Sensor Technology

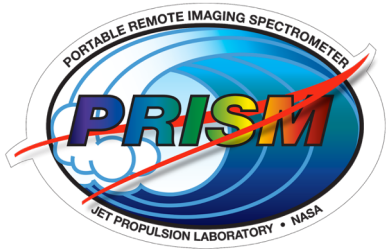
NASA G3 and G5 Research Aircraft 3 imaging spectrometers and LiDaR

Nearly complete spectral coverage + Lidar



Reflectance from UV through Shortwave Infrared (UV-SWIR) capture canopy-level physical and biological characteristics





ELSEVIER

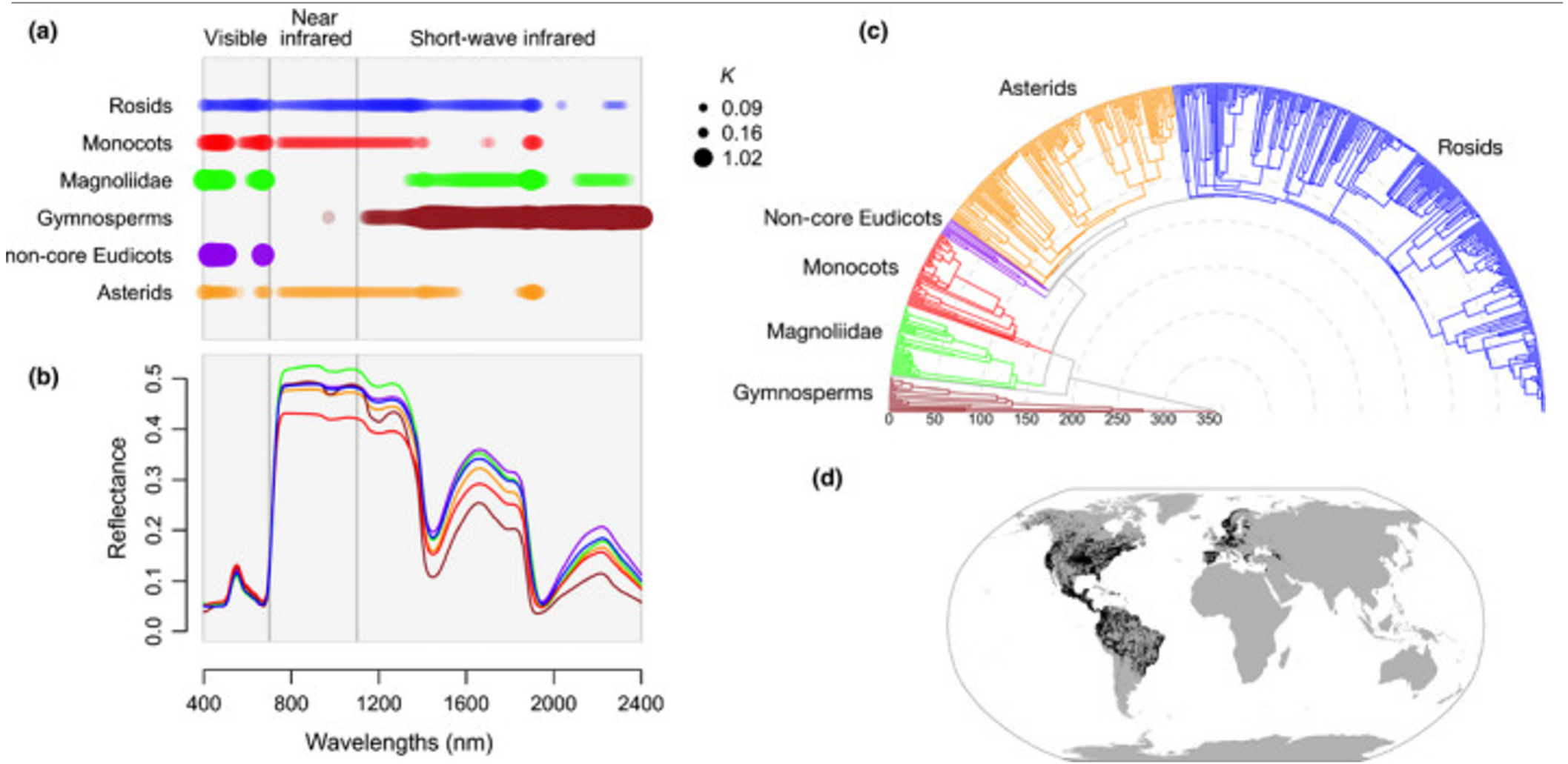
Remote Sensing of Environment
Volume 257, May 2021, 112349

Review

NASA's surface biology and geology designated observable: A perspective on surface imaging algorithms

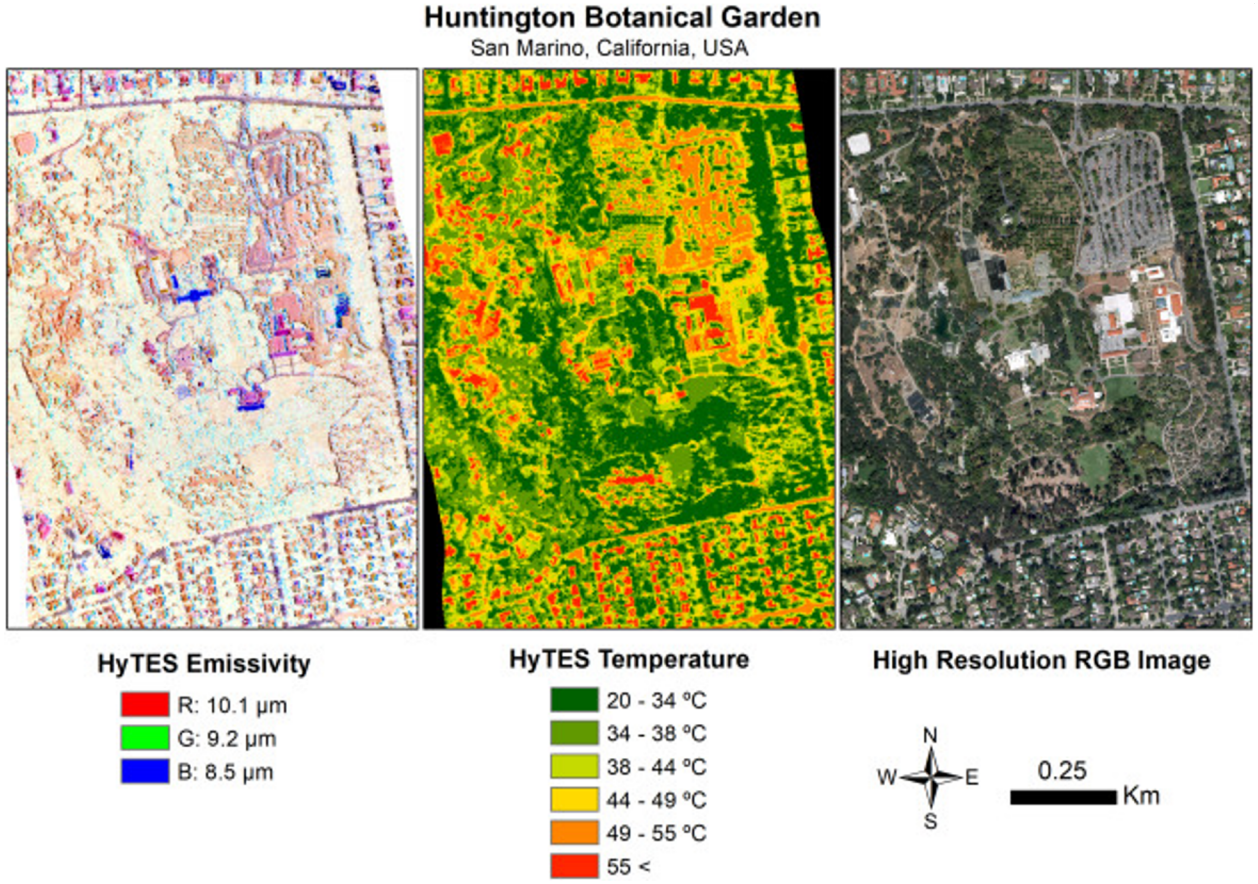
Kerry Cawse-Nicholson, et. al (2021) https://doi.org/10.1016/j.rse.2021.112349

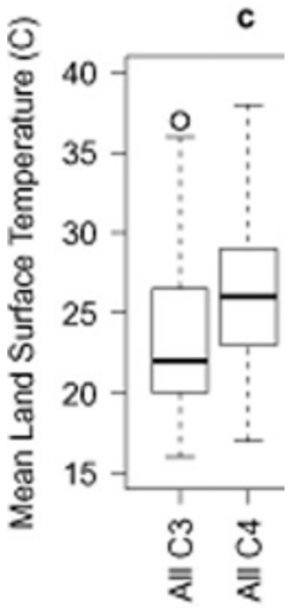
Leaf reflectance spectra captures the evolutionary history of seed plants



Meireles, et. al. *New Phytologist* 2020 Oct; 228(2): 485–493 DOI://10.1111/nph.16771

Canopy emissivity and land and water surface temperature with HyTES





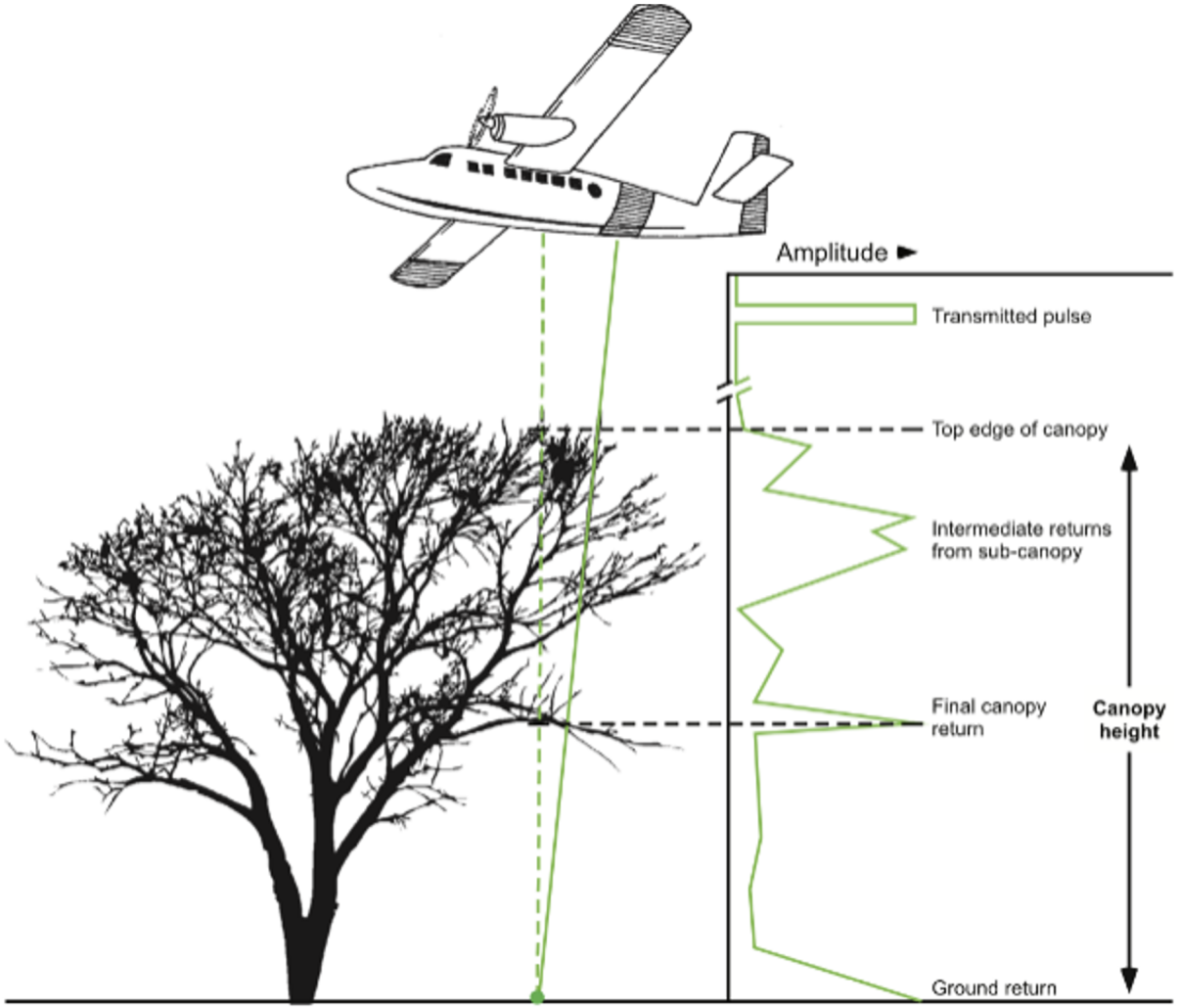
Temperature a driver for plant microclimates

Example: notable differences in thermal environments of C3 and C4 plants

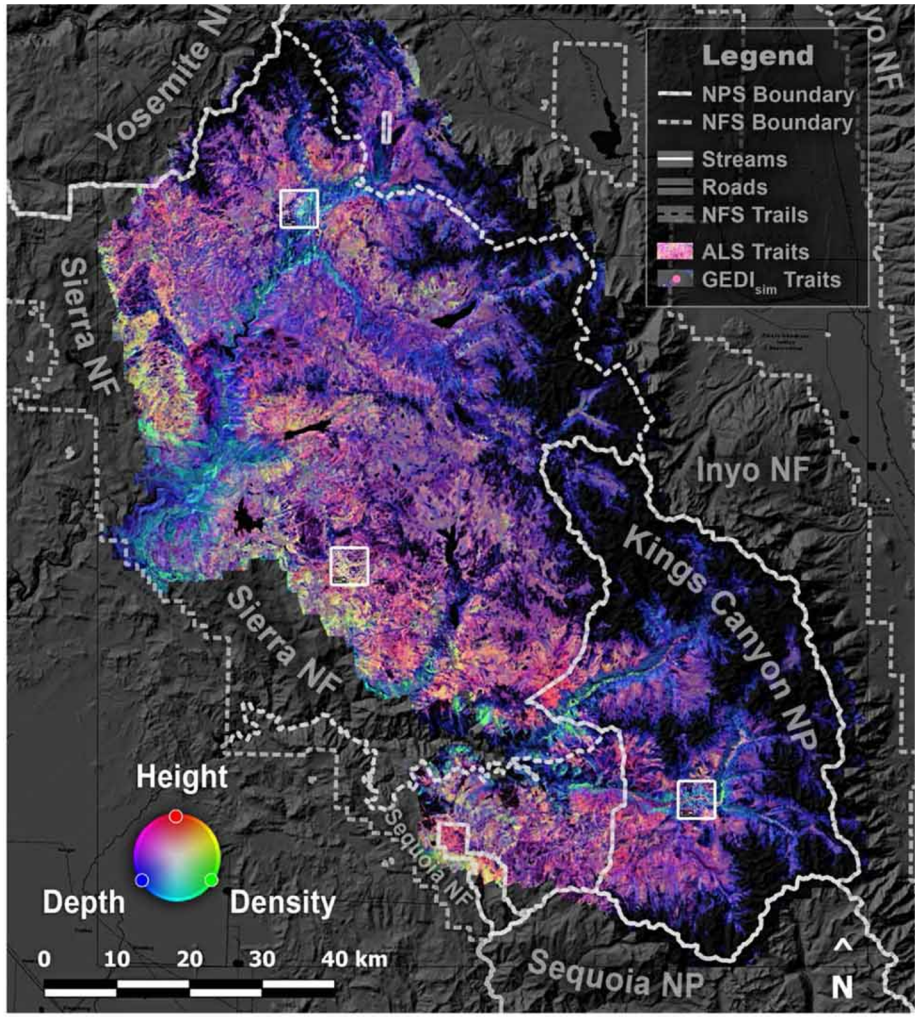
Susan Meerdink et al. 2019 Remote Sensing of Environment

Christopher Still et al. 2014 *Global Ecol & Biogeography*

Canopy Structure with Lidar

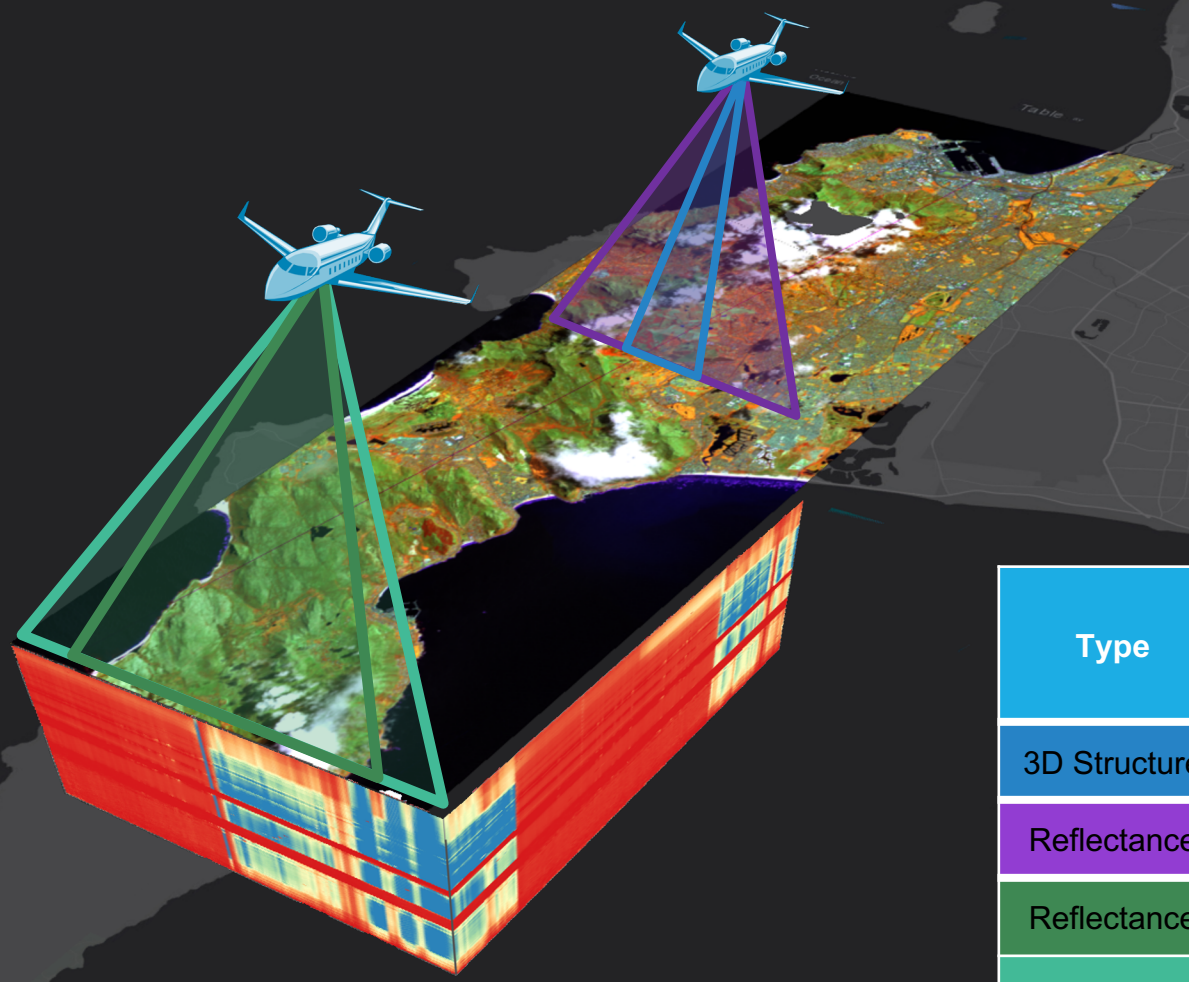


[Purkis & Klemas 2011]



Fabian D Schneider et al 2020 Environ. Res. Lett. 15 115006

Sensor Integration



Imagery processed to Surface Reflectance on a common grid (identified by science team).

Type	Instrument	n spectral bands	Spectral Res (nm)	Swath width (km)	Spatial res (m)
3D Structure	LVIS	1	1	2 - 3	6 - 10
Reflectance	PRISM	608	2.83	5 - 8	8 - 13
Reflectance	AVIRIS-NG	480	5	6 - 10	9 - 14
Thermal	HyTES	256	17.6	10 - 16	12 - 20

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Funding Opportunities

NASA Biological Diversity (Woody Turner & Keith Gaddis)

- Biodiversity and Ecological Forecasting ROSES Call for Proposals
- ≈$2m / year supporting 10-27 awards
- *Proposals in review*

South African National Space Agency (Stewart Bernard)

- New Earth Observation Frontiers (NEOFrontiers) Funding Framework
  - 2021 Deadline Passed, future calls possible

US National Science Foundation

- Division of Environmental Biology (NSF 21-504, no deadline)
  - Biodiversity on a Changing Planet (BoCP)
  - Also: Systematics and Biodiversity Science, Evolutionary Processes, Population and Community Ecology, Ecosystem Science
- Macrosystems Biology and NEON-Enabled Science (MSB-NES)
  - NSF 20-506, second Monday in November, annually
- Division of Ocean Sciences (Biological Oceanography)
  - Open call (no deadline)

Biodiversity on a Changing Planet (BoCP)

Integrative approach to *understand biodiversity from a functional perspective* with the use of new technology and team science approaches.

Functional Perspective: the roles that organisms play within populations, communities, and ecosystems in ecological and evolutionary processes and patterns (including species generation, loss, reorganization, and maintenance.)

Emergent properties at all levels of biological organization and functions not directly under selective pressure.

Deadline: March 25, 2022

Expected funding from NSF:
3-year $500k
5-year $2.5m

Expected funding from NRF:
Up to two 3-year ZAR1.8M ($120k)
Up to two 5-year ZAR10.0M (~$670k) projects

Learn more at

bioscape.io/project

OR

www.nsf.gov/pubs/2022/nsf22508/nsf22508.htm

Diversity, Equity, and Inclusion

From the ROSES RFP:

3.2 South African Partnerships

NASA strongly encourages proposals to contain partnerships with South African organizations and individuals to ensure the relevance of proposed GCFR research to South Africa's people and ecosystems. All things being equal, South African partnerships will make for a stronger, more highly-rated proposal.

3.6 Inclusion

Inclusion is a core NASA value. By fostering an atmosphere of inclusion and respect for all, we value the strengths afforded by both our commonalities and differences with an aim to fully engage and utilize talents, ideas, and perspectives. Projects that offer an opportunity to tap the nation's diverse talent pool and increase participation in Earth science and remote sensing are encouraged. NASA is interested in increasing the diversity of race, ethnicity, gender, ability, and career stage in science teams.

AGU 2021 Workshop:

Bringing 'parachute science' back to Earth to improve remote sensing of biodiversity for all

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Virtual Workshop
Tuesday, 7 December 08:00 - 11:00

Parachute science: when scientists, often from wealthier nations, visit a location, collect data, and publish results with minimal engagement with the local scientists and/or decision-makers.

BioSCape as an example to brainstorm and co-design strategies to enhance scientific engagement.


Adam M. Wilson


Erin Hestir


Jasper Slingsby


Asha de Vos


Anabelle Cardoso


Woody Turner


Izak Smit

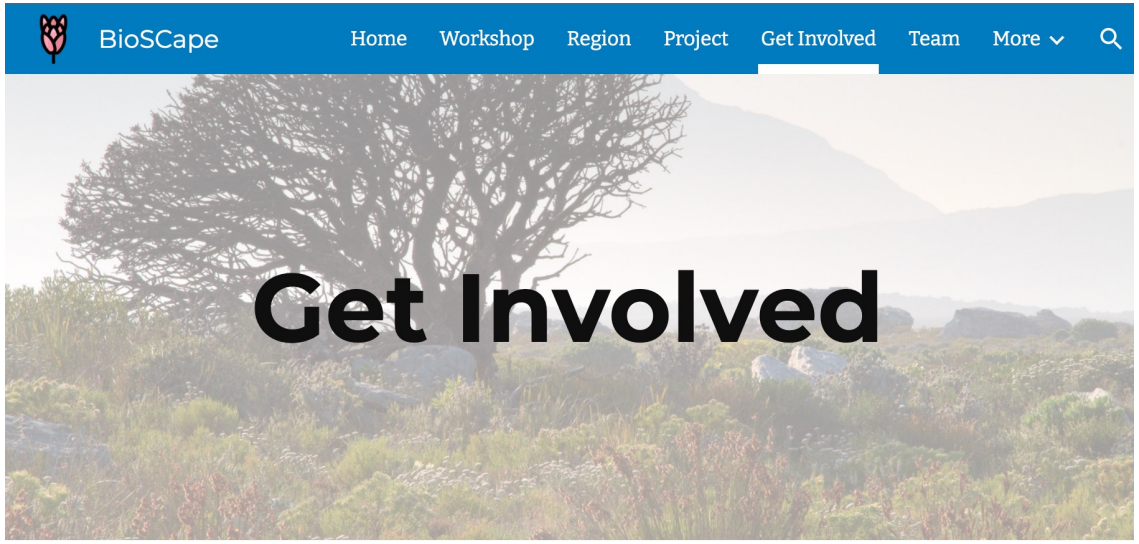
AGU FALL MEETING
New Orleans, LA & Online Everywhere
13-17 December 2021

bioscape.io

All data freely available soon after collection

Join the mailing list at bioscope.io/contact

Look for the workshop at AGU



There are several ways to get involved in the field campaign, from subscribing to our email list to proposing a project to NASA.

- Subscribe to the email list here to get emails about this project as it develops.
- Fill out the form below to be included in a list of potential collaborators.
- If you are a US-based researcher, consider applying for a NASA grant to work on the project. Details here.
- Contact the Science Team at bioscape [AT] wilsonlab.io to discuss conducting an affiliate project to use the airborne data collected by this field campaign.

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Thank you!

BioSCape.io

Join the mailing list!

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